Karlsruhe Institute of Technology

CVPR JUNE 3-7, 2026 DENVER COLORADO

SAIAD Workshop

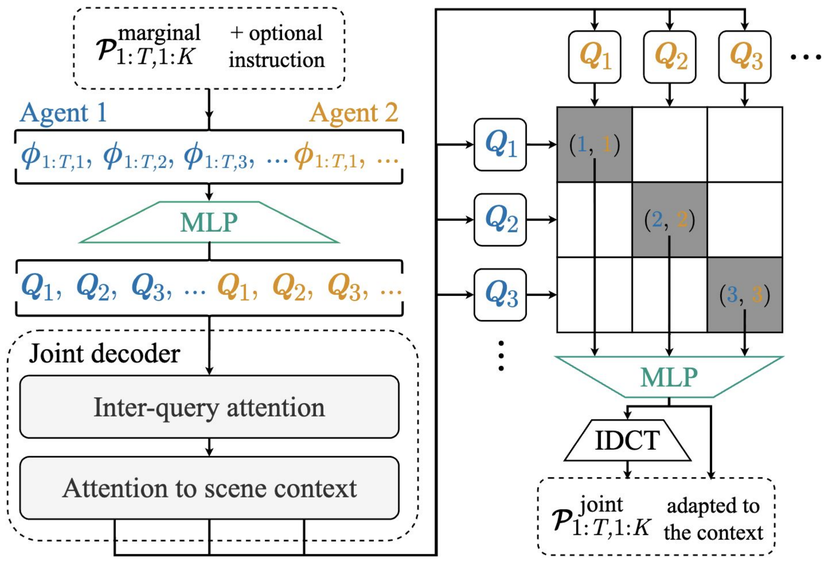
GitHub repo

nxt AIM

FZI

RetroMotion: Retrocausal Motion Forecasting Models are Instructable

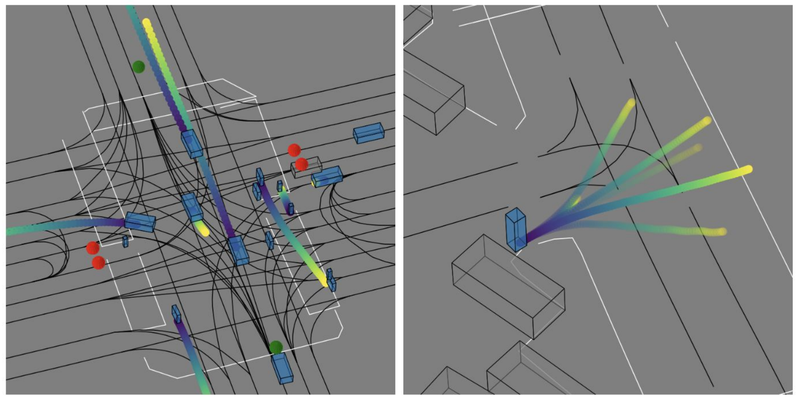
Royden Wagner, Omer Sahin Tas, Felix Hauser, Marlon Steiner, Dominik Strutz, Abhishek Vivekanandan, Jaime Villa, Yinzhe Shen, Carlos Fernandez, Christoph Stiller



$$\mathcal{P}^{\text{marginal}}_{t,1:K}(\boldsymbol{y} \mid \boldsymbol{x}) = \sum_{k=1}^{K} m_k(\boldsymbol{x}) \cdot \mathcal{D}\big(\boldsymbol{y} \mid \boldsymbol{\phi}_{t,k}(\boldsymbol{x})\big),$$

$$\mathcal{P}^{\text{joint}}_{t,1:K}(\boldsymbol{y} \mid \boldsymbol{x}) = \sum_{k=1}^{K} c_k \sum_{a=1}^{A} M_{k,a}(\boldsymbol{x}) \cdot \mathcal{D}\big(\boldsymbol{y} \mid \boldsymbol{\phi}_{t,k,a}(\boldsymbol{x})\big),$$

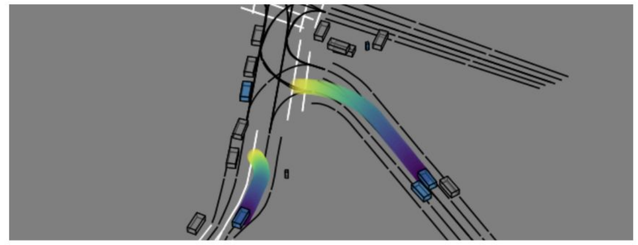
Retrocausal flow of information from later points in marginal trajectory distributions to earlier points in joint distributions.



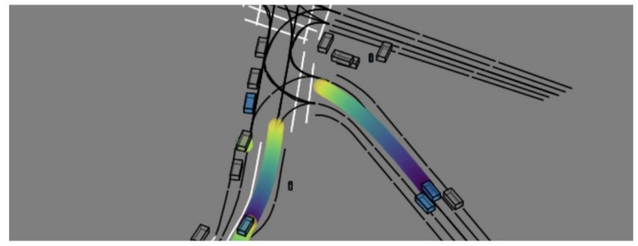
(c) Complex scenario (d) 6 marginal modes

Method (config)	mAP↑	minFDE↓	OR↓
Test split			
Scene Transformer (joint) [34]	0.1192	2.1892	0.2067
GameFormer (joint) [21]	0.1376	1.9373	0.2112
SceneMotion (joint) [50]	0.1789	2.3141	0.2163
JointMotion (HPTR) [49]	0.1869	2.0507	0.2037
MotionDiffuser [24]	0.1952	1.9482	0.2004
JFP [31]	0.2050	1.9905	0.1835
MotionLM [39]	0.2178	2.0067	0.1823
MTR++ [41]	0.2326	1.9509	**0.1665**
QCNeXt [56]	0.2352	**1.6772**	0.1946
BeTopNet [29]	0.2412	2.2744	0.1695
RetroMotion [ours]	0.2397	1.9591	0.2020
RetroMotion (SMoE) [ours]	0.2422	2.0245	0.2007
RetroMotion (SMoE hybrid) [ours]	**0.2519**	2.0890	0.1927

RetroMotion performs well on interactive scenarios of the Waymo Open Motion dataset.



turn left instruction as modified trajectories



Joint trajectories adapted to the scene context

Instruction	Eval. trajectory	OR↓		ORP↑	
turn left	basic instruction	0.23		0.64	
	adapted joint traj.	0.18	-22%	0.85	+33%
turn right	basic instruction	0.21		0.76	
	adapted joint traj.	0.18	-14%	0.91	+20%

OR: Overlap rate with other road users,
ORP: On-road probability

RetroMotion adapts basic instructions to the scene context (other road users and lanes).